

## 2 DEPOSIT 1 REMEDIATION

### 2.1 Basis of Design

Deposit 1 lies on the north side of the channel beginning approximately 150 feet upstream of Upriver Dam, and continuing approximately 2,100 feet upstream (Figure 2). Beyond the upstream boundary of Deposit 1, the river makes a slight bend that effectively directs river flow away from Deposit 1, thereby minimizing erosive forces on this sediment deposit. Deposit 1 is located in an old river channel that has retained its shape while the rest of the channel to the south of the Deposit has been subjected to lateral scour as the river turns past the bend.

The cleanup remedy for Deposit 1 includes placement of a clean cap system over relatively fine-grained surface (0 to 10 cm) sediments containing PCB concentrations exceeding 62  $\mu\text{g}/\text{Kg}$  dry weight (dw). A three layer cap has been designed that provides an absorptive base layer of bituminous coal on top of the contaminated sediments. The second layer is a base cap designed to cover the coal and provide a buffer between layers. The final layer is a gravel armor layer designed to withstand reasonable worst-case erosive forces expected in this section of the river. In addition, cap placement methods have been designed to minimize mixing during cap placement and to further ensure successful construction of a protective cleanup remedy. General cap design considerations relevant to Deposit 1 are provided in the *Draft Final Focused Feasibility Study Upriver Dam PCB Sediment Site* (FS; Anchor 2005b) and the *Remedial Design Work Plan Spokane River Upriver Dam PCB Site* (RDWP; Anchor 2005c). This Engineering Design report further describes the basis of design that was presented in the *30 Percent Design Technical Memorandum* (Anchor 2006).

#### 2.1.1 Horizontal Boundaries

Multiple surface and sub-surface sampling events have occurred in the vicinity of Deposit 1 (Figure 2) to determine the horizontal extent of surface sediments that contain PCB concentrations exceeding 62  $\mu\text{g}/\text{Kg}$  dw. The results of these sampling events were presented in the FS (Anchor 2005b). The analysis of surface grabs 1SG through 9SG (Figure 2) defined the southernmost boundary of Deposit 1, as these grab samples all contained PCB concentrations below the 62  $\mu\text{g}/\text{Kg}$  dw sediment cleanup standard. This southern boundary also coincides with coarser sand and gravel materials, based on visual observations during diving operations. As depicted in Sheet B1 of Appendix A,

control points have been developed from these data that delineate the southern Deposit 1 sediment cleanup boundary.

The northern boundary of Deposit 1 rests against the slope of the Spokane River channel bank (control points F through O), the upper portions of which are armored with riprap. The horizontal extent of the northern edge of Deposit 1 was defined by calculating the maximum slope angle for cap placement.

Since the gradation of the coal material ranged from fine to medium sand to coarser sand, it will likely be placed at a porosity of approximately 40 percent. Material of this gradation and porosity is expected to have a friction angle of 26 to 30 degrees (Lambe and Whitman 1969). An infinite slope analysis was conducted to determine the maximum stable angle of the slope. Given the lighter weight of the coal, presence of currents, and limited uncertainty of the placement, a safety factor of 1.5 was used. The infinite slope analysis resulted in a slope angle of 18 degrees which equates to a slope gradation of 3 horizontal to 1 vertical (3H:1V). Therefore, the cap will be limited to areas flatter than 3H:1V on the northern extent.

To design the northern boundary on a construction drawing, a Geographic Information Systems (GIS) model was created to plot the slope of the northern bank of the channel near Deposit 1. The resulting data showed the various slope angles of the bank and allowed for an accurate design of the northern boundary where the slope reached 3H:1V.

The eastern extent of the Deposit 1 boundary was based on interpolated sampling data with PCB concentrations less than the 62  $\mu\text{g/Kg}$  dw cleanup standard, also considering the geomorphology of the riverbed (Figure 2). Upstream of the eastern edge of the cap boundary, the river turns and coarser-grained sand and gravel deposits predominate in this area.

The western extent of the Deposit 1 boundary was also based on interpolated sampling data with PCB concentrations less than the 62  $\mu\text{g/Kg}$  dw cleanup standard. The western edge of the boundary nearly extends to the Upriver Dam concrete apron (Figure 2).

## 2.2 Capping

### 2.2.1 Cap Design

As described in the RDWP (Anchor 2005c) and the *30 Percent Design Technical Memorandum* (Anchor 2006a) and summarized in the sections below, the Deposit 1 cap design follows current EPA and U.S. Army Corps of Engineers (Corps) cap design guidance (Palermo et al. 1998a and 1998b).

Detailed video, bathymetry, dive, and bottom profiling surveys of Deposit 1 were conducted during the RI (Anchor 2005a) to delineate debris (e.g., logs) that protruded more than 12 inches above the mudline. Relatively little debris was identified in Deposit 1, and no debris was identified that could potentially compromise the integrity of the cap.

The minimum thickness of the designed cap system for Deposit 1 is 13 inches. The coal layer will be placed first to a minimum of 4 inches above the starting surface mudline (Appendix A, Sheet B1). Due to its physical characteristics (e.g., specific gravity of approximately 1.3 grams per cubic centimeter [ $\text{gms}/\text{cm}^3$ ]), placement of the coal layer as the initial lift of the cap will minimize mixing of the cap into the underlying sediments, concurrently minimizing potential resuspension of contaminated sediments into the water column. The coal layer will then be overlain with a minimum of 6 inches of base cap that meets design specifications. The base cap serves as a buffer between layers and provides a stable cap over the coal. The base cap will be required to contain less than 5 percent fines to minimize turbidity impacts during construction. An analysis of turbidity during construction can be found in section 2.2.8. The final gravel armor layer will be a minimum of 3 inches and was designed to withstand reasonable worst-case erosive forces expected in this section of the river. A detailed description of the erosion protection can be found in section 2.2.6. The complete cap system will have a minimum thickness of 13 inches.

Given the inherent difficulties in achieving accurate placement tolerances for in-water construction, an additional thickness (“over-placement allowance”) is typically specified in capping contracts. For Deposit 1, the over-placement allowance is 6 inches for each of the three layers. The over-placement allowances are in addition to the minimum layer

thicknesses summarized above, and are based on anticipated cap placement equipment (e.g., 2-cubic yard [cy] mechanical clamshell), experience at other similar capping projects, and considerations of likely contractor incentives to limit the amount of excess thickness. Therefore, the coal layer will consist of a 4-inch required minimum thickness with an over-placement allowance of 6 inches. The base cap layer will consist of a 6-inch minimum thickness with a 6-inch over-placement allowance, and the final gravel armor layer will be a minimum of 3 inches with a 6-inch over-placement allowance. The complete cap system will thus have a maximum thickness of 31 inches. Specification language includes a 6-inch average over-placement allowance per layer. The placed thickness will be verified in the field with detailed construction monitoring observations (e.g., piston core sampling) to ensure that the minimum thicknesses are attained. Cap thickness verification procedures are further discussed in the CQAP (Appendix B) and in section 2.2.10 of this report.

### **2.2.2 Remediation Area and Volume**

The surface area of the designed cap for Deposit 1 is 151,150 square feet (sf). The coal layer has a required thickness of 4 inches with a 6-inch over-placement allowance. Thus, up to approximately 4,700 cy of coal material may be placed on the Deposit 1 cap. The base cap layer consists of a 6-inch minimum thickness with a 6-inch over-placement allowance, which equates to up to 5,600 cy of material. The final gravel armor layer will be a minimum of 3 inches with a 6-inch over-placement allowance for a total quantity of up to 4,200 cy of material. Combining all cap layers, a maximum of approximately 14,500 cy of material will be placed on Deposit 1.

### **2.2.3 Base Cap and Armor Layer Material**

Several local potential sources of base cap and armor material are available in the Spokane area including Central Pre-mix and Rock Products, Inc. Both are potential suppliers of the appropriate grain size and quantity of material at regionally competitive prices. Once a source is selected by the contractor, assurance will be provided that imported base cap and armor material are natural, native, virgin materials and free of contaminants, including debris or recycled materials, and meet construction specifications (see CQAP; Appendix B). The contractor will inspect all materials and

submit a report detailing the source, location, and date of material as well as the results of the following tests:

- Grain size distribution (American Society for Testing and Materials [ASTM] method D422-63)
- In-situ moisture content (ASTM method D2216)
- Priority Pollutant Metals (EPA publication SW846, the 6000/7000 method series)
- Volatile organic compounds (EPA publication SW846, method 8260 as modified by Puget Sound Estuarine Protocols [PSEP])
- Semivolatile organic compounds (EPA publication SW846, method 8270 as modified by PSEP)
- PCBs (EPA publication SW846, method 8082 as modified by PSEP)
- Pesticides (EPA publication SW846, method 8081 as modified by PSEP)
- Total organic carbon (Standard Methods [SM] method 5310B).

The base cap material will meet Ecology (2003) freshwater lowest apparent effects threshold (LAET) chemical guidelines and will also meet the following gradation limits:

<u>Sieve Size</u>	<u>Percent Passing (by weight)</u>
U.S. No. 4	100
U.S. No. 10	25 to 100
U.S. No. 40	20 to 60
U.S. No. 200	5 max

The armor layer material will be primarily igneous or metamorphic rock and also meet Ecology (2003) LAET chemical guidelines. The gradation limits are listed below:

<u>Sieve Size</u>	<u>Percent Passing (by weight)</u>
4-inch	100
1-inch	50 max
U.S. No. 40	20 max
U.S. No. 200	5 max

Earlier discussions presented in the *30 Percent Design Technical Memorandum* (Anchor 2006a) indicated that potential sources of gravel and sand could be found at the staging

area. After inspecting the site further, these sources have been removed from consideration.

#### **2.2.4 Bituminous Coal Material**

An inventory of potential coal sources meeting the general design requirements outlined in the RDWP (Anchor 2005c) was performed as part of the initial remedial design activities, focusing on prospective sources located closest to Spokane. The results as well as detailed physical and chemical descriptions the coal source material can be found in the *30 Percent Design Technical Memorandum* (Anchor 2006a). Appendix A (Fall 2005 Coal Sampling and Analysis Data) of that report contains all of the raw data. Based on these results three acceptable coal sources were identified:

1. The Elk Valley Coal Corporation has several coal mining operations located in southern British Columbia near Cranbrook. Relatively fine-grained coal materials meeting the remedial design specifications are available from their wash plant operations and are stored submerged in a process pond.
2. The Spring Creek & Decker Mines located in the Powder River basin (Montana) provides a range of suitable coal products. The coal material is typically shipped as a sand and gravel-sized product, though finer materials are also available.
3. Palmer Coking Coal in Black Diamond, Washington provides a relatively fine-grained “buckwheat” coal product.

#### **2.2.5 Chemical Leachability of the Coal Material**

In order to assess potential short- and long-term water quality effects during and following placement of the coal in Deposit 1, representative samples were submitted for modified elutriate testing (MET; Palermo 1986) and porewater testing (Michelsen et al. 1998). Single extraction/batch tests, such as the MET, simulate the release of dissolved constituents from solid material into the water phase, and such tests commonly employ a liquid to solid ratio of 20:1 and a contact time of 24 hours to achieve steady-state or near-equilibrium conditions (Ecology 2003). Spokane River water was used as the leachant in all tests. Slurries of the different coal products were prepared for the MET and porewater tests at a concentration of 20:1 liquid to solid ratio by volume. The slurries were aerated for 1 hour (to simulate reasonable worst-case turbulence anticipated during placement), and allowed to settle for 24 hours. Water samples for

MET analysis were extracted from the midpoint of the water column. The elutriate samples were analyzed for standard water quality parameters (turbidity, total suspended solids [TSS], pH, dissolved oxygen, conductivity, and temperature), along with dissolved target metals (0.45-micron filter; arsenic, cadmium, chromium, copper, mercury, nickel, lead, and zinc). These results, along with an analysis of the Spokane River water used as the leachant, are summarized in the *30 Percent Design Technical Memorandum* (Anchor 2006a).

The coal materials that settled during the MET test were separated from the overlying elutriate and submitted for porewater extraction and testing. Porewater extractions were performed according to Puget Sound Dredge Disposal Analysis (PSDDA) protocols (Michelsen et al. 1998; <http://www.nws.usace.army.mil/PublicMenu>). The solids were extracted by double centrifuging and the extracted water was filtered (0.45-micron) for analysis of dissolved arsenic, cadmium, chromium, copper, mercury, nickel, lead, and zinc.

The results of the elutriate and porewater testing are presented in the *30 Percent Design Technical Memorandum* (Anchor 2006a). Most of the chemical parameters analyzed were not detected. The results demonstrate that all prospective coal products contain very low levels of potentially hazardous substances. All elutriate samples were below screening values and only one parameter (lead) exceeded the screening values for one sample (Palmer Coking Coal) in the porewater test. Because the exceedance was minor and was for one parameter, this material is still considered acceptable for use as cap material. The screening values are based on Ecology's WAC 173-201A surface water quality standards, incorporating updates promulgated under the National Toxics Rule and adopted under MTCA and WAC 173-201A. Based on bulk chemistry, elutriate, and porewater data, all three potential coal sources are considered potentially suitable for application at the site.

### **2.2.6 Chemical Isolation**

The FS (Anchor 2005b) presented the results of remedial design level chemical transport modeling performed following current EPA and Corps cap design guidance (Palermo et al. 1998a and 1998b). The chemical isolation thickness required to ensure the long-term



effectiveness of the cap systems was based on the results of one-dimensional chemical transport modeling. The model presented in Reible (1998) was used, which is an appendix to the EPA and Corps cap guidance (Palermo et al. 1998a and 1998b). The model applied to this cap design described advective/diffusive transport of PCBs through the coal layer of the Deposit 1 cap. By neglecting the additional attenuation properties of the overlying sand and armor layer, the model provides a conservative remedial design level estimate of the required thickness and material specification of the coal layer.

The one-dimensional chemical transport model revealed that long-term effectiveness of the Deposit 1 cap can be achieved by specifying a minimum coal thickness of 4 inches and a minimum carbon loading of the coal layer of 40 kilograms per square meter ( $\text{kg/m}^2$ ), providing a minimum factor of safety of 4 to the overall cap design (Anchor 2005b). In order to achieve a carbon loading of 40  $\text{kg/m}^2$  with a minimum placed thickness of 4 inches, the coal placed in Deposit 1 must have a carbon content of at least 30 percent, assuming a coal density of 1.3  $\text{grams/cm}^3$ . To ensure precision placement and optimal efficiency, the material must also be granular. Testing of the most promising coal materials identified for placement in Deposit 1 was discussed in the *30 Percent Design Technical Memorandum* (Anchor 2006a), and indicated that all three potential coal sources are potentially suitable for application at the site.

### **2.2.7 Erosion Protection**

Cap armor design considerations relevant to Deposit 1 are provided in the FS (Anchor 2005b). Consistent with cap design guidance presented in Palermo et al. (1998a and 1998b), the surface of the Deposit 1 cap was designed to maintain its integrity under reasonable worst-case environmental and human use conditions (e.g., to resist shear stresses under a 100-year flood condition).

Stable sediment size was determined based on maximum predicted velocities that can occur at the site. These velocities were computed by dividing design flow value in the river by river cross-sectional area at the site. Avista (2004) conducted a flow analysis in the lower portion of the river and developed a 100-year flow value of 53,900 cubic feet per second (cfs) and was used as the design flow value for the analysis.



Based on this velocity, stable sediment size was computed using the following methods:

- Hjulstrom's diagram, as presented in Vanoni (1975)
- Plate B-28, entitled "Noncohesive Sediment Gradation and Permissible Velocity," as presented in the Corps' *Hydraulic Design of Flood Control Channel* (1994)
- Plate B-29, entitled "Stone Stability: velocity vs stone diameter," as presented in the Corps's *Hydraulic Design of Flood Control Channel* (1994)
- Shield's diagram, as presented in Shields (1936), based on bottom shear stress associated with channel average velocity. A Shield coefficient of 0.047 corresponding to gravel size material was used (Grindeland 2003). Bottom shear stress associated with design velocities was computed based on the following equation (WES 1998):

$$\tau = \frac{1}{2} \rho f_c U^2$$

Where:

$\tau$  represents the bottom shear stress

$\rho$  represents the density of freshwater

$f_c$  represents a friction coefficient

$U$  represents the average velocity in the river

Using the four methods described above, the median stable sediment size computed for the Deposit 1 area is at or below 1 inch. The design specifications presented in section 2.2.3 were based on these calculations and should provide for sufficient stability and resistance to erosion in Deposit 1 for the following reasons:

- Deposit 1 is located in a deeper portion of the site, in a backwater area where fine sediments have accumulated.
- The bottom slope at the project area is very flat (approximately 1V:170H), and shear stress computed based on site slope and hydraulic radius (Henderson 1966) led to a relatively small size in the required erosion protection layer, indicating that finer material is theoretically stable in this region.

### **2.2.8 Turbidity Modeling**

The Spokane River is classified as class A water under WAC 173-201A, which includes a project-related turbidity limit of less than a 5 nephelometric turbidity unit (NTU) increase over background if upstream turbidity is less than 50 NTU. If upstream background turbidity is greater than 50 NTU (which is relatively rare in the Spokane River), then up to a 10 percent increase in turbidity over the background reading is allowed. During construction, and consistent with the requirements of WAC 173-201A, turbidity standards must normally be met at a point 150 feet downstream of the Deposit 1 remedial action area, or approximately at the Upriver Dam spillway (Figure 2).

For the purposes of this remedial design, TSS mass balance and associated turbidity modeling was performed to evaluate reasonable worst-case turbidity releases that may be associated with cap placement actions in Deposit 1. The modeling was based on the following set of assumptions:

- Cap placement will occur during fall low flow conditions in the Spokane River (USGS 2006). Preliminary forecasts of river flow in the Upriver Dam area during the prospective in-water construction period (September and October 2006) range from roughly 1,000 to 3,000 cfs, consistent with historical records (Gary Stockinger, Avista; personal communication, January 2006). With an average cross-section area in the Deposit 1 vicinity of approximately 8,400 sf (Anchor 2005b), the stream velocity during the construction period may range from roughly 4 to 11 cm/sec (0.1 to 0.4 feet/sec). Given an average width in the Deposit 1 remedial action area of approximately 100 feet, and an average water depth of approximately 22 feet, discharge through the Deposit 1 remedial action area may range from 260 to 790 cfs during construction.
- Based on a review of site conditions in Deposit 1, evaluation of capping projects performed in similar environments, and discussions with regional contractors, cap placement by mechanical clamshell bucket is likely to be most efficient means of construction. Consistent with EPA and Corps cap design guidelines (Palermo et al. 1998a and 1998b), the following assumptions were made in calculating an average production rate for capping:
  - 2-cy mechanical clamshell bucket capacity
  - 75 percent bucket load efficiency

- 50 to 60 percent “up-time”
- Cycle time of 1.5 minutes
- Capping performed over one 12-hour shift per day

Based on these parameters, an average hourly cap placement production rate of 30 cy per hour is estimated for Deposit 1. This production rate includes down-time associated with movement and repositioning of the derrick barge.

- During placement, some of the fines present in the cap materials could potentially be released into the water column and may not readily settle onto the sediment surface (Palermo et al. 1998a and 1998b). These fines could potentially contribute to TSS concentrations in the downstream water column. To estimate reasonable worst-case turbidity during construction, it was assumed that up to half of the fines present in the coal and base cap could potentially be suspended into the water column and transported downstream. (However, careful placement of cap materials with a mechanical bucket would achieve considerably lower sediment suspension.) Thus, during coal placement (i.e., delivery of material with up to 38 percent fines—such as Elk Valley coal), up to 130 kg/hr of TSS could potentially be released to the water column. If the other prospective sources of coal are used (i.e., from Spring Creek & Decker Mines or Palmer Coking Coal), a lower amount of TSS (30 kg/hr or less) would be released. Similarly low TSS releases (30 kg/hr or less) are associated with sand cap placement. Based on mass balance calculations, these TSS loads equate to potential TSS increases during capping operations as follows:
  - Elk Valley Coal – TSS increases from roughly 1.6 to 4.7 mg/L
  - Spring Creek and Decker Mines or Palmer Coking Coal – TSS increases from 0.4 to 1.2 mg/L
  - Sand cap – TSS increases from 0.4 to 1.2 mg/L
- The relationship between TSS and turbidity can be variable. However, the average ratio of turbidity to TSS observed in the coal elutriate tests presented in the *30 Percent Design Technical Memorandum* (Anchor 2006a) was 3.2 NTU per mg/L. Based on this general correspondence, potential TSS increases during capping operations between 0.4 to 4.7 mg/L equate to estimated turbidity increases ranging from approximately 1 to 15 NTU. As discussed above,

predicted turbidity increases will vary depending on the specific capping material used, as follows:

- Elk Valley Coal – turbidity increases from roughly 5 to 15 NTU
- Spring Creek and Decker Mines or Palmer Coking Coal – turbidity increases from 1 to 4 NTU
- Sand cap – turbidity increases from 1 to 4 NTU

These calculations reveal that if coal obtained from the Spring Creek & Decker Mines or Palmer Coking Coal is used for the Deposit 1 cap, expected construction-related turbidity increases will be below the 5 NTU increase allowed under the state water quality standards. In this situation, prospective compliance with the turbidity standard during construction is indicated without the need for further analysis. Turbidity monitoring will be performed during cap placement to verify compliance with water quality standards and to determine the need for any further operational controls (see Appendix B).

The calculations summarized above also suggest that if Elk Valley coal is used for the lower section of the Deposit 1 cap, construction-related turbidity increases could potentially and periodically exceed the 5 NTU increase allowed under the state water quality standards. However, because of the conservative assumptions used, these calculations provide only an initial screening-level estimate of reasonable worst-case turbidity that may occur during construction. In any event, turbidity monitoring will be performed during cap placement to verify water quality compliance and to determine the need for any further operational controls (see Appendix B).

### **2.2.9 Access Routes and Staging Areas**

Further site visits following the *30 Percent Design Technical Memorandum* (Anchor 2006a) identified that the most promising Deposit 1 staging area for this project is the western half of a currently vacant City of Spokane property located along the south shore of the river immediately upstream of Upriver Dam (Figure 4). This area is already graded and has limited vegetation and other obstructions that would preclude use of the site as a staging area. A formal right of entry request for the temporary use of the property will be submitted by Avista to the City of Spokane following submittal of this Draft Final

Design report. The prospective staging area has road access, is located in close proximity to the Burlington Northern Santa Fe mainline (Figure 1), and can be used as a platform to support mechanical (barge-based) or hydraulic (pipeline-based) methods of cap placement. Delivery trucks and construction equipment moved during the mobilization/demobilization phase will enter the site via E. Trent Road (State Road 290) to N. Waterworks Street, driving around the Police Academy to the vacant lot depicted in Figure 4. A short path may need to be built to provide access from N. Waterworks Street to the staging areas. The contractor will prepare the lot for use during construction and delivery of the specified capping material. The contractor will provide sufficient measures within the staging/stockpiling area to prevent mixing of the capping materials while also providing adequate space for loading of the material onto barges. The staging/stockpiling area will be sufficiently protected to resist erosion caused by wind and rain. Silt fences, ecology blocks, jersey barriers, and other items are examples of measures that may be used for environmental protection of the site and adjacent properties. A security fence may also be installed around the staging/ stockpiling area. A front-end loader will likely be stationed at the staging/stockpiling area to continually manage the stockpiles. Upon completion of the work, the contractor will remove all remaining capping material, barriers, liners, and other materials and clean up the site to the pre-project condition.

#### ***2.2.10 Cap Placement Methods and Quality Control***

As discussed in section 2.2.2, in order to place the designed three layer capping system, up to approximately 4,700 cy of coal, 5,600 cy of base sand and 4,200 cy of gravel armor material will be purchased, delivered, and placed to the specified extents and thicknesses.

Several types of equipment and cap placement techniques have been successfully implemented on numerous capping projects in recent years, including the following:

- Direct placement with a mechanical clamshell bucket near the bottom
- Surface release from a bucket, barge, hopper, or skip box
- Spreading with hydraulic pipeline and diffuser box or plate
- Submerged diffuser or tremie
- Washing off barge with high powered jet

These potential cap placement techniques have been evaluated with respect to site conditions at Deposit 1 and relative to experience with other capping projects performed in similar environments. These techniques were also designed to minimize the mixing of the cap material with the existing sediments, thus preventing contaminated sediments from entering the water column. In addition, the physical settling characteristics of the proposed coal materials have been evaluated for their implications on construction methods.

Based on these considerations, placement by mechanical clamshell bucket is likely the most efficient means of cap construction. A pilot cap will be placed by the contractor prior to initiating the capping operations. The contractor will demonstrate their approach and techniques with a pilot cap. The pilot cap location is shown on the drawings in Appendix A. The intent of the pilot cap is to observe the contractor's proposed methods of capping for compliance with the performance criteria, assess the contractor's proposed quality control methods, and confirm successful placement of the required thickness and extent of capping material.

Subject to design refinements based on the pilot study, the following is a general description of the sequence of construction events envisioned for placement of the cap material:

- Capping material from the staging/stockpiling area will be loaded onto a scow barge most likely with a conveyor type system.
- A contractor's tug will then maneuver the scow and derrick from the docking position at the staging/stockpiling area into position at Deposit 1. To avoid surface tension and inadequate placement, the contractor will saturate the coal before placement.
- The derrick will unload the saturated coal material from the scow. Individual loads of coal material will be lowered through the water surface by a derrick using a small clamshell bucket to a depth within 2 feet of the riverbed prior to slowly releasing the material. The slow release of the coal capping material will allow the material to gently flow through the water column. The material is predicted to settle freely and evenly on the sediment surface.

- Water quality monitoring will be performed during cap placement to verify that turbidity standards are met at a point 150 feet downstream of the Deposit 1 remedial action area, or approximately at the Upriver Dam spillway. The background turbidity measurement will be made 300 feet upstream of the Deposit 1 remedial action area. Water quality monitoring at each location will target three depths: 1 foot below water surface, mid-depth, and 1 foot above the mudline. Routine ambient monitoring activities will be performed at these locations on two occasions immediately prior to the beginning of construction (to establish baseline water quality conditions) and while construction is in progress. Detailed water quality monitoring plans can be found in the CQAP (Appendix B). If turbidity above allowable limits is noted at either of the downstream locations during construction, the contractor may need to temporarily cease operations and/or develop alternate placement methods.
- At regular intervals during construction, the thickness of coal layer will be verified using piston cores or equivalent methods to ensure that the specified minimum thickness (4 inches) has been placed. Detailed verification sampling and associated quality control plans are included in the CQAP (Appendix B).
- After the coal layer has been verified as meeting the project specifications, the base sand cap layer will be placed.
- The scow will be maneuvered back to the staging/stockpiling area to receive the base cap layer material. As with the procedures for the coal material, the cap sand will be loaded onto the flat scow and maneuvered back into place next to the derrick.
- The base sand cap will be placed using a clamshell bucket opened within 5 feet of the water surface. The bucket will be opened slowly and concurrently swung from side to side. The slow release of the base sand cap will allow the material to gently flow through the water column. Because of the low percentage of fines (less than 5 percent), the material is predicted to settle freely and evenly on the coal surface.
- The base sand cap layer thickness will then be verified by cap placement quality control measures similar to those used to assess the coal layer prior to the placement of the final armor layer.



- In the same fashion as the base sand cap layer, the armor material will be delivered to Deposit 1 from above the water surface. The armor layer thickness will then be verified by cap placement quality control measures.

The clamshell bucket will be equipped with a global positioning system (GPS) to ensure accurate cap placement within the limits defined on the construction plans. In addition, a GPS grid in the derrick cab will likely be positioned in front of the cap placing derrick to provide the operator a visual guide and means of confirming placement volumes (i.e., spreading of a given bucket volume over a constant grid area).